Global Carbon Cycle Program (GCC)
Information Sheet FY2010

Background

The global carbon cycle is changing rapidly as a result of human actions, altering Earth's climate. Many research priorities identified in the 1999 U.S. Carbon Cycle Science Plan remain important, including improved measurement, observations, and monitoring of the carbon cycle, as well as experiments that manipulate the carbon cycle on land and in the oceans, and observation and modeling studies of processes that control the current and future carbon balance. New priorities for carbon cycle research are, however, beginning to emerge. These priorities include studies of: 1) the effects of human activities on carbon cycling, 2) the vulnerability and resilience of ecosystems to changes in carbon cycling and associated changes in climate, and 3) the efficacy and environmental consequences of carbon management policies, strategies, and technologies. Additional emphasis is also needed to evaluate uncertainties in our understanding of the global carbon cycle and to coordinate researchers from different scientific disciplines to study a common problem. These priorities will enable progress in the basic sciences, and will provide stronger scientific input to decision makers for carbon cycle management.

The goal of the Global Carbon Cycle (GCC) Program is to improve our ability to predict the fate of anthropogenic carbon dioxide and future atmospheric carbon dioxide concentrations, but in the context of the above emerging priorities. GCC conducts studies by using a combination of:

1) Research leading to better understanding of key processes and sources of uncertainty for projections of future greenhouse gas concentrations, such as the impacts of ocean acidification on the carbon cycle, or CO_2 and CH_4 fluxes from rapidly warming high latitudes.

2) Specific improvements on how key processes or parts of the carbon cycle are represented in climate or earth system models so that the models are not limited to the present day conditions but can perform well under scenarios involving significant change.

3) Novel tools to measure biogeochemical variables crucial for the global carbon cycle in the ocean or the atmosphere, which would drastically reduce the cost per measurement and enable much higher spatial and temporal resolution than what is feasible today. These may include but are not limited to low-power, stable sensors that could be deployed in large numbers on autonomous platforms, drifters, profiling floats, towers or commercial aircraft.

While the goal of the Global Carbon Cycle (GCC) Program remains to improve our ability to predict the fate of anthropogenic carbon dioxide (CO_2) and future atmospheric CO_2 concentrations using a combination of atmospheric and oceanic global observations, process-oriented field studies and modeling, for 2010 GCC research is integrated across four over-riding themes:

FY 2010 Priorities

Causes of Variability in Sources and Sinks

The rate of increase of carbon dioxide in the atmosphere can vary significantly on inter-annual and decadal time-scales. The causes of this variability are largely unknown: while a small amount is a result of variations in emissions, the majority is due to variability in uptake by the oceans and terrestrial biosphere. Studies are needed which investigate how various factors influence variability in the ocean and terrestrial carbon sinks over a variety of temporal scales, and identify which factors are the most important.

Future Atmospheric Carbon Dioxide Concentrations

Current models used to project future atmospheric carbon dioxide concentrations assume that the carbon cycle will continue to operate in the same way it has operated in the recent past. These models do not take into account the limitations of the carbon sink on land, or how biological, chemical and physical processes in the ocean and land might change either due to natural variability or external forcing. By examining the carbon cycle as an integrated system, identifying how it interacts with climate and other influences such as land use patterns, and incorporating the carbon cycle into dynamic earth system models, more realistic predictions of future atmospheric carbon dioxide concentrations and potential abrupt changes in growth rate can be made.

Ocean Carbon Cycling and Biogeochemical and Ecosystem Dynamics

There is an increasing need to understand the interactions between ocean carbon cycling and ecosystem and biogeochemical dynamics in response to increased levels of CO_2. Despite increased efforts to understand the important controlling processes, significant discrepancies still exist between models and observations, and a number of key processes remain poorly quantified. The goal is to conduct research to resolve limitations and discrepancies in our understanding and prediction of ecosystems, biogeochemical cycles and carbon uptake. Examples of specific areas of research are:

1) Biogeochemical Cycling & Carbon Production/Export
2) Marine Food Webs & Ecosystems
3) Ocean Acidification

North American Carbon Monitoring

Atmospheric and oceanic data and models have produced varying estimates of the magnitude and variability of the Northern American carbon sink. In addition, experience has shown that inventory estimates of emissions are often quite far off from actual emissions when they are confronted with atmospheric data. There is considerable debate over the methods for improving these estimations and the processes controlling them. The initial focus of this research theme is to identify responsible mechanisms using ocean

and atmospheric field experiments, observations, models, or combinations thereof, as for example in CarbonTracker, to constrain estimates of the Northern Hemisphere carbon emissions and sinks.

The list above is not meant to be exclusive and investigators who have additional ideas are highly encouraged to submit a Letter of Intent briefly describing the scientific merit and relevance to NOAA of their proposed topic.

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